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Adaptive Texture Alignment for Japanese Kimono Design

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Abstract – *A yukata is a type of traditional Japanese kimono. An alignment of its texture pattern is an important factor of the yukata design. There are rules in the texture alignment of the yukata. The rules are comparatively simple. However, the texture alignment is difficult for the designer because the texture alignment should be performed with consideration to the rules and the wearer's taste. Additionally, it is necessary for the designer to create the cutting pattern from a limited length of the kimono cloth.*

Consequently, a design support system for the yukata is required. We have developed the image processing algorithm to simulate the condition of the texture alignment. It becomes possible to perform the texture alignment based on the traditional rule automatically. However, some cutting pattern becomes over length of a standard kimono cloth.

In this paper, we describe a multi-agent system for supporting the texture alignment of the yukata. We developed texture alignment agents, and a management agent. The management agent acts management of the wearer's body sizes, the condition of the texture alignment and the cutting pattern and orders to the texture alignment agents to carry out the texture alignment according to the wearer's taste. By repeating trial and error, the realistic texture alignment became possible.

Keywords – *Japanese kimono, Yukata, Apparel CAD, Image processing*

I. INTRODUCTION

A yukata is a type of traditional Japanese kimono. An alignment of its texture pattern is an important factor of the yukata design.

The texture alignment is performed by adjusting the cutting position of the yukata parts, such as the bodies and sleeves so that the arrangement of texture patterns on each parts may satisfy the traditional texture alignment rules and the wearer's taste. The process of the texture alignment of the yukata is the complicated job for designers. In this paper, we describe about a multi-agent system for the texture alignment.

There are traditional rules in the texture alignment of the yukata. The rules are comparatively simple. However, the texture alignment is an important design process because the texture alignment should be carried out with consideration to the rules and the wearer's taste. Additionally, it is necessary for the designer to create the cutting pattern from a limited length of the kimono cloth.

Consequently, a design support system for the yukata is required. We have developed the image processing algorithm to simulate the condition of the texture alignment. It becomes possible to perform the texture alignment based on the traditional rule automatically. However, a texture alignment often causes cutting patterns with over length of the standard kimono cloth.

In this paper, we describe a multi-agent system for supporting the texture alignment of the yukata. The management agent controls the texture alignment agents to perform the appropriate texture alignment. After repeating automatic trials, the realistic texture alignment became possible.

II. METHODS

Fig.1 shows the basic structure of the yukata. The yukata consists of several parts; a right body, a left body, a right sleeve, a left sleeve, a right overlap, a left overlap and a collar. Fig. 2 shows the cutting pattern of the yukata. One yukata cloth is cut separately for bodies, sleeves, overlaps and the collar in rectangle.

The texture alignment should be performed to be satisfied the traditional rules of the texture alignment. For example, the texture alignment of the yukata with stencil pattern is performed so that the stencil patterns are not concentrated on attractive areas of attentions. Therefore, it becomes important to get the best result in the texture alignment trial.

Fig.3 shows the texture alignment of the yukata with stencil patterns. The texture alignment of the yukata with the stencil pattern is performed by following rules as follows.

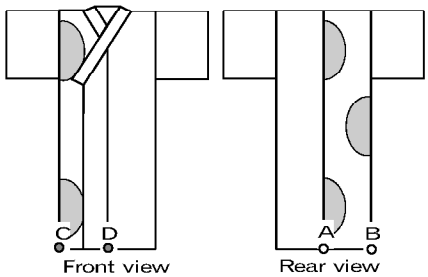


Fig. 1 Basic of yukata.

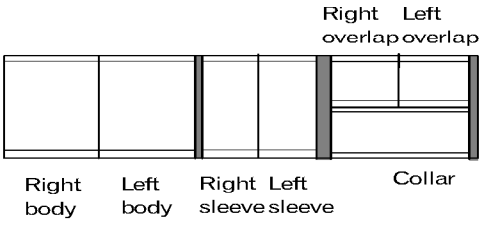


Fig. 2 Cutting pattern.

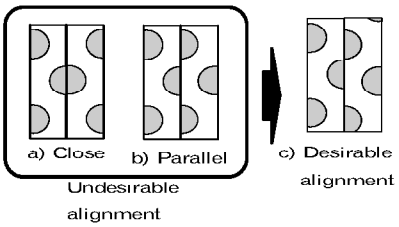


Fig.3 Texture alignment with the stencil patterns.

i) A stencil pattern should be positioned on the hem of the left overlap.

ii) Stencil patterns must not be close to each other.

iii) Stencil patterns must not be positioned horizontally.

iv) Stencil patterns should be positioned in well-balanced location.

Fig.4 shows the attractive areas of attention in the yukata design. The most important areas in the texture alignment are the hem of the left overlap Oh, the chest B, the body O, the hip H, the left shoulder Sr and the right shoulder Sl.

Fig.5 shows the texture alignment of the left overlap. The designer arranges a stencil pattern into the hem region Oh as shown in Fig.5 a). According to this arrangement, the cutting position of the left overlap is moved from the cutting position 1 to the cutting position 2 as shown in Fig.5 b). After the texture alignments, the designer evaluates the designed yukata. If the designed yukata does not satisfy the wearer's taste, the designer revises the texture alignment.

The important areas of the texture alignment are different with the wearer. The designer revises the texture alignment so that the texture alignment in the important areas for the wearer may become desirable. This process is performed by the designer's trial and error.

We propose a multi agent system that performs the texture alignment automatically. Fig.6 shows the texture alignment method. In this figure, the texture alignment between the left overlap and the left body is done by changing the position of the left body. At first, the stencil patterns of the left body and the left over lap are transformed into curves in order to

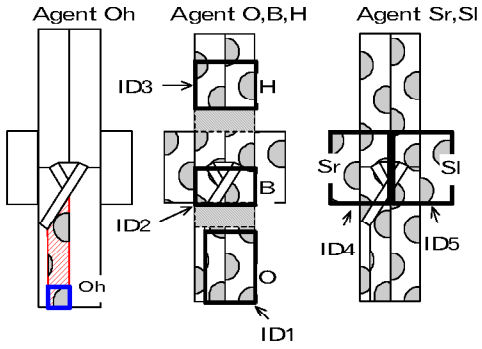
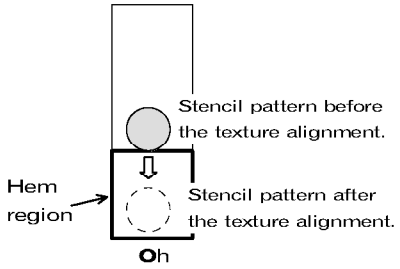
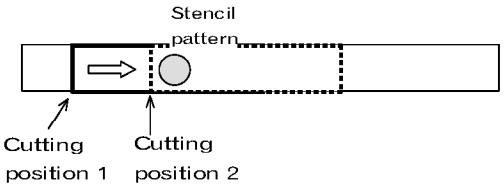


Fig.4 Attractive areas of attentions of the yukata design.



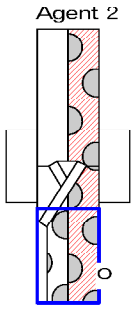
a) Texture alignment of the left overlap.



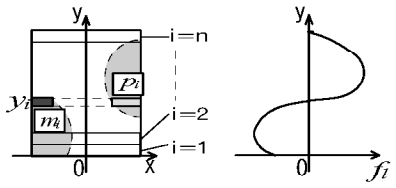
b) Cutting pattern of the left overlap.

Fig.5 Texture alignment of the overlap.

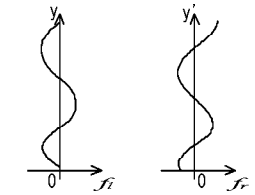
indicate the condition of the texture. Fig.6 b) shows the curve f_l about the stencil patterns of the left overlap. The stencil patterns of the left body is transformed into the curve f_r. Next, a correlation value R between f_l and f_r is calculated. The condition of the texture alignment can be evaluated from a correlation value R. Fig.6 c) shows an example of the desirable texture alignment. In this case, the value of the correlation value R is near to 0. The texture alignment agent decides cutting positions so that the correlation value R becomes near to 0. We use an objective function value, which is the absolute value of R, to evaluate the condition of the texture alignment in such an attractive area as O region.



a) Attractive area.



b) Transformation of the stencil patterns into a curve.



c) Evaluation of the texture alignment.

Fig. 6 Texture alignment method of the left body.

Furthermore, the objective function values, such as ID2, ID3, ID4 and ID5 are calculated. In this way, the texture alignments of the right body, the left sleeve and the right sleeve are done.

Fig.7 shows the multi-agent system for the texture alignment of the yukata. The system consists of a management agent, a database and texture alignment agents. The management agent is the interface between the designer and the texture alignment agents. The positions and the sizes of the parts as shown in Fig.8 are used as the cutting pattern information. The traditional rules of the texture alignment for various texture patterns are obtained from a database. The texture alignment agents evaluate the condition of the texture alignment for each part of the yukata and perform texture alignment so that the conditions of the texture alignment satisfy the traditional rules and the wearer's taste. The 5 texture alignment agents for the yukata parts are used. For example, agent 1 (ag1) evaluates the texture alignment of the

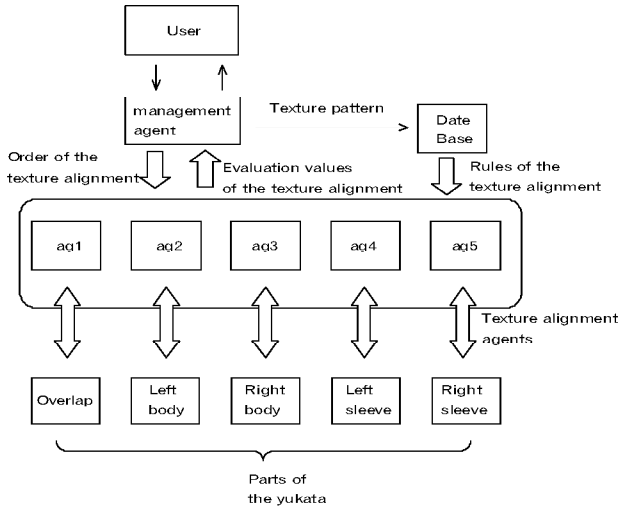


Fig.7 Multi agent system for texture alignment.

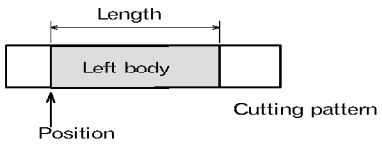


Fig.8 Cutting pattern of the left body.

left overlap as shown in Fig.5 a). If the condition of the texture alignment is not suitable, the agent ag1 performs the texture alignment of the left overlap as shown in Fig.5 b).

The process of the texture alignment using proposed agent system is as follows.

i) The wearer input the wearer's body sizes such as height, sleeve plus shoulder length and a waist size, the texture pattern of the cloth, and the important areas of the texture alignment to the management agent. And, the rule and the evaluation method of the texture alignment are on the texture alignment agents.
ii) The size of the yukata is estimated from the wearer's body sizes such as the height, the hip and the sleeve plus shoulder length. The cutting pattern of the yukata without the texture alignment is created.
iii) The texture alignment of the left overlap is performed.
iv) The objective values ID1, ID2, ID3, ID4 and ID5 are calculated.
v) The management agent selects a yukata part, where the values of the objective function is near to 1, and sends the order the retry of the texture alignment to the texture alignment agent of the selected part.

Table 1 The objective values of the attractive areas.

Objective functions	Before texture alignment	After texture alignment
ID1	0.070462	0.003125
2×ID2+ID3	0.435913	0.016654
ID4	0.176968	0.008946
ID5	0.391756	0.004696
I = ID1+2× ID2+ID3+ID4+ID5	1.075099	0.033421

vi) The texture alignment agent sends the revised cutting pattern to the management agent.

vii) The management agent examines the revised cutting pattern if the revised cutting pattern influences parts besides in the cutting pattern. For example, the management agent check the cutting pattern if the left body overlaps to the right body. If the revised cutting pattern cannot be accepted, the management agent orders another agent to retry the texture alignment.

viii) The condition of the texture alignment is evaluated again. Texture alignment is finished when all agents judge that texture alignment is appropriate, and the management agent outputs the cutting pattern of the yukata. If the result of the texture alignment does not satisfy the traditional rules or the wearer's taste, the process of the texture alignment from v) to vii) is repeated.

III. RESULTS

A female student who is 163 cm in height, 68 cm in the shoulder plus sleeve length and 88 cm in the hip designed herself her own yukata with this CAD system. She chose a kimono cloth with flower patterns. The flower pattern is a kind of the stencil pattern. Figure 15 shows the yukata with flower patterns without the texture alignment. Table 2 shows results of the objective functions. In this case, the value of the total objective function I was 1.075099. Figure 16 shows the result of texture alignment. The value of the total objective function I was 0.033421.

By repeating these processes, the management agent determines the cutting pattern to the wearer. In this way, we can obtain the result of the texture alignment as shown in Fig.9.

By using the multi-agent system, we can perform the texture alignment systematically and efficiently.

IV. CONCLUSIONS

In this study, we developed a multi-agent system for the texture alignment, which performs automatic texture alignment of the yukata. The management agent is useful to achieve reasonable texture alignment.

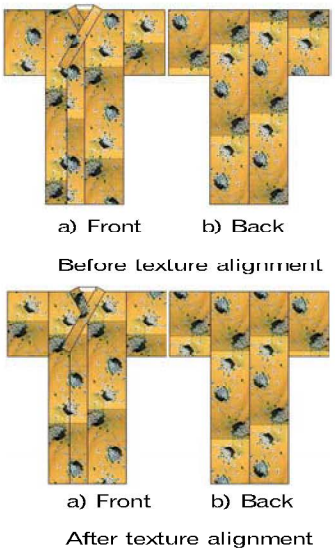


Fig.9 Results of texture alignment.

For achieving the automatic texture alignment, at first the image processing algorithms to convert the texture pattern of the kimono cloth to the objective functions was developed. Next, we developed the evaluation method of the texture alignment by the objective function in the attractive areas of attention.

By using this design support system, designers can easily tailor the yukata regardless of their skill.

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